Developing Fuel-Efficient, Low-Emission Heavy Vehicles

Researchers at Argonne are teaming with DOE's Office of Heavy Vehicle Technologies (OHVT), engine manufacturers, and truck component suppliers to develop the enabling technologies for next-generation, fuel-efficient, low-emission heavy vehicles — a market that extends from over-the-road tractor trailers to multipurpose vehicles (the rapidly growing market segment consisting of pickups, vans, and sport-utility vehicles). Trucks of all classes combined already use more energy than automobiles, and their energy share is expected to increase.

OHVT's strategy is to focus on the diesel engine because of its inherent high thermal efficiency and lower energy use in fuel processing. Argonne is leveraging existing expertise in diesel engines and related technologies (such as high-temperature ceramics and diamond-like carbon coatings) to support OHVT's strategy. Because Argonne is in the Midwest diesel engine "belt," easy access to major engine manufacturers like Caterpillar and Cummins is possible. Argonne also serves as the lead lab in systems analysis for OHVT. Argonne assesses the impact of engine and vehicle technologies and nonpetroleum fuels on energy consumption, emissions of criteria pollutants, and greenhouse gas emissions.

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Argonne National Laboratory is committed to research and development leading to **high-quality, cost-effective products** that meet the nation's goal of improving energy efficiency, reducing emissions, and manufacturing affordable, advanced-technology vehicles.

The Laboratory has forged **partnerships** with many firms in the energy and transportation sectors over the past two decades. Our location, right in the nation's heartland and industrial center, makes cooperative research accessible and cost-effective.

Argonne's innovative research in **computer modeling and technology development** is helping to provide solutions to the challenges of creating a new generation of vehicles. These programs are supported by the Department of Energy and U.S. industry.

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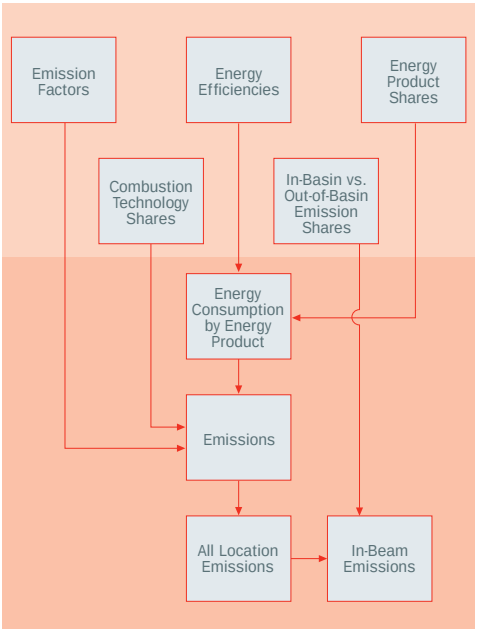
MODELING & ASSESSMENT of Vehicle Options



Estimating changes in vehicle-related energy use and emissions that would occur with the introduction of electric vehicles

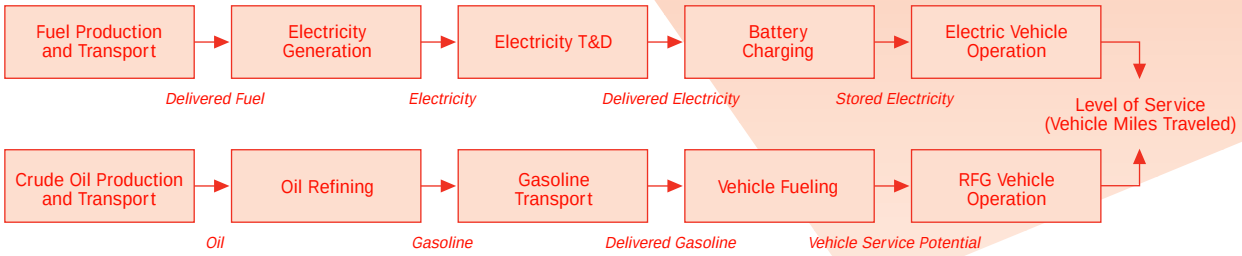
Understanding the full fuel cycle through computer modeling

Developing fuel-efficient, low-emission heavy vehicles

ARGONNE NATIONAL LABORATORY

Using EVTECA to Compare Competing Transportation Technologies

Argonne is providing insight into how changes in transportation technologies and fuels will affect the industry and the environment.



Total energy cycle analyses can be used to compare the energy use and emissions of competing transportation technologies. Argonne is one of three national laboratories participating in a total energy cycle assessment of electric vehicles (EVTECA) sponsored by DOE. The EVTECA, for which Argonne is providing technical management, inventories the potential energy use and emissions associated with the use of significant numbers of electric vehicles (EVs) in selected metropolitan areas of the United States.

Researchers use the energy use and emissions estimates resulting from the EVTECA to compare a similar inventory for conventional vehicles (CVs) operating on reformulated gasoline. From this comparison, they can estimate the changes in vehicle-related energy and emissions that would occur with the introduction of EVs. The figure shows the *fuel-cycle* stages covered in the analysis.

The EVTECA analysis has provided the following preliminary results:

- EVs will reduce energy use—relative to energy use by CVs—over the total energy cycle by 15–40%.
- Total oil use will be reduced by 50–85%.
- Total energy cycle VOC and CO emissions will be reduced by 85–90% (even more in urban areas).
- Total NO_x emissions will be reduced by highly variable amounts.
- CO_2 emissions will be reduced by highly variable amounts.

On the other hand, replacing CVs with EVs can result in some increases in CH_4, TSP, SO_x, and Pb.

Computer Modeling

Argonne has developed a model, the Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) model, to estimate per-mile, *fuel-cycle* emissions and the rates of energy use for various transportation fuels. The model can include the *vehicle cycle*, depending on user needs. The vehicle cycle includes raw material production, material fabrication, vehicle assembly and finishing, and vehicle component disposal/recycling.

Argonne has developed a second model, the Integrated Market Penetration and Anticipated Cost of Transportation Technologies (IMPACTT), to evaluate both per-mile emissions and energy use (estimated by using GREET) of an evolving fleet of vehicles, by future year, accounting for the pace of market penetration of the new technology and replacement of the old. IMPACTT incorporates a vehicle stock module that provides annual profiles of vehicle population by age; a usage module to compute vehicle miles traveled, oil displacement, and fuel use; and an emissions module to compute *fuel-cycle* emissions of regulated pollutants and greenhouse gases.

The U.S. DOE's Office of Transportation Technologies has used both GREET and IMPACTT to evaluate the energy and emissions impacts of introducing advanced transportation technologies. The models have also been used by the Partnership for a New Generation of Vehicles (PNGV) to investigate the impacts of introducing vehicles with tripled fuel economy on the fuels infrastructure. DOE has used the estimated per-mile emissions and energy impacts of new transportation technologies and fuels obtained by using GREET in preparing rulemaking, testimonies to Congress, and responses to requests by various groups.

Many alternative transportation fuels are under consideration to reduce use of petroleum fuels, air pollution, and global warming. Good research practice today requires that researchers evaluate the energy and emissions impacts of these transportation fuels over the full *fuel cycle.* GREET and IMPACTT are versatile tools that can be used to assess the full *fuel cycle* quickly and efficiently.